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Present-day and early heat flows on Mars: implications for thermal evolution

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There is currently a very interesting and productive debate on the present-day heat flow and thermal state of Mars. The very high (>300 km) effective elastic thickness deduced for the north polar region from the non significant flexure caused by loading due to the north pole cap, is related to a low surface heat flow at the present-time, hardly reconcilable with most of thermal history models. This low heat flow could be indicative of sub-chondritic heat-producing elements (HPE) abundances, a limited influence of secular cooling, or simply a regional variability of surface heat flow. On the other hand, effective elastic thicknesses of Noachian-loaded regions are very low (typically ~15 km or lower), indicating high heat flows, which is espectable for a young planet. Otherwise, the depth to the brittle-ductile transition beneath Late Noachian-Early Hesperian lobate scarps (considered to be related with large thrust faults) is ~20-35 km, which can in turn be converted to heat flows of ~25-45 mW m-2. These values are lower than those predicted by thermal history models of Mars, and than the heat flow equivalent to the total radioactive heat generation. The discrepancy between deduced and predicted Late Noachian-Early Hesperian lobate heat flows could be explained by a limited contribution from secular cooling, as already proposed for explain the present-day heat flow in the north polar region. However, it could also be explained an efficient hydrothermal cooling of the upper crust, which was previously proposed to explain the preservation of large-scale crustal thickness variations observed in the southern highladns. Thus, the comparison between heat flows estimated from both the effective elastic thicknesses of the lithosphere and the depth to the brittle-ductile transition, and those predicted by thermal history models, may serve to put constraints on the evolution of the efficiency of several ways of heat loss (including vigorous hydrothermal coolings) on Mars.

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